US Army Corps of Engineers®

Ice Engineering

U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

Ice Events in the St. Louis District

Rivers in the northern United States, including those within the boundaries of the St. Louis District, are subject to ice events that delay or stop navigation (Fig. 1); damage riverine structures such as locks, dams, bridges, dikes, levees, and wingwalls; cause damage to tows, barges, and mooring/fleeting areas; block hydropower and water supply intakes; cause flooding; and decrease downstream discharge. Roads may be flooded and closed, or bridges weakened or destroyed, limiting emergency and medical relief to the affected areas. The potential exists for death or serious injury caused by jam and flood conditions, and during evacuations and other ice mitigation operations. Also, ice movement and ice jams can severely erode streambeds and banks, with adverse effects on fish and wildlife habitat.

The lack of readily available information on historical ice events hinders rapid, effective response to ice-related flooding and other damage. It also prevents an accurate assessment of damages, which are estimated to cost about $100M annually in the United States. Engineers and state officials work together to prevent damages caused by ice events, and many are working to anticipate future measures required to prevent serious ice events from forming.

These efforts depend upon accurate and reliable ice event data that can be used to research previous ice events, to predict and assess conditions that may increase the probability of an ice jam formation, and to document steps taken by engineers and relief officials in previous years when confronted with ice jam conditions during emergency situations. The CRREL Ice Jam Database was developed to provide a centralized record of ice events, and now contains information on more than 11,000 ice events.

Database entries include the name of the water body; the city and state where the ice event took place; the date of the ice event; the ice event type, if known; a brief description of damage; the names of CRREL and Corps personnel familiar with the event or site; reference to visual records of the event, if available; latitude and longitude; USGS gage number, if available; and hydrologic unit code.

Records also contain narrative descriptions of ice events (some of which can be several pages) and a list of information sources. There is a separate database entry for each discrete ice event at a given location.

St. Louis District ice events

This bulletin provides a brief summary of information in the CRREL Ice Jam Database for rivers within the jurisdiction of the U.S. Army Corps of Engineers St. Louis District. Established in 1872, the St. Louis District covers about 28,000 square miles in Missouri and Illinois (Fig. 2).

District boundaries contain 48,000 miles of waterways, including 300 miles of the Mississippi River from its confluence with the Ohio River at Cairo, Illinois, to just south of Saverton, Missouri, the lower 80 miles of the busy Illinois River, the lower Missouri River (in St. Charles and St. Louis counties), and the Kaskaskia River, among others.

Navigation is important in the St. Louis District, which operates Locks and Dams 24, 25, and Melvin Price, the Chain of Rocks Canal, and Lock 27 on the Mississippi River, and Kaskaskia Lock and Dam on the Kaskaskia River.

As of September 1998, 182 ice events that occurred between 1842 and 1997

Figure 1. View from Lock and Dam 26 toward Alton, Illinois, showing ice jammed upstream from the dam (29 January 1960).

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Abstract

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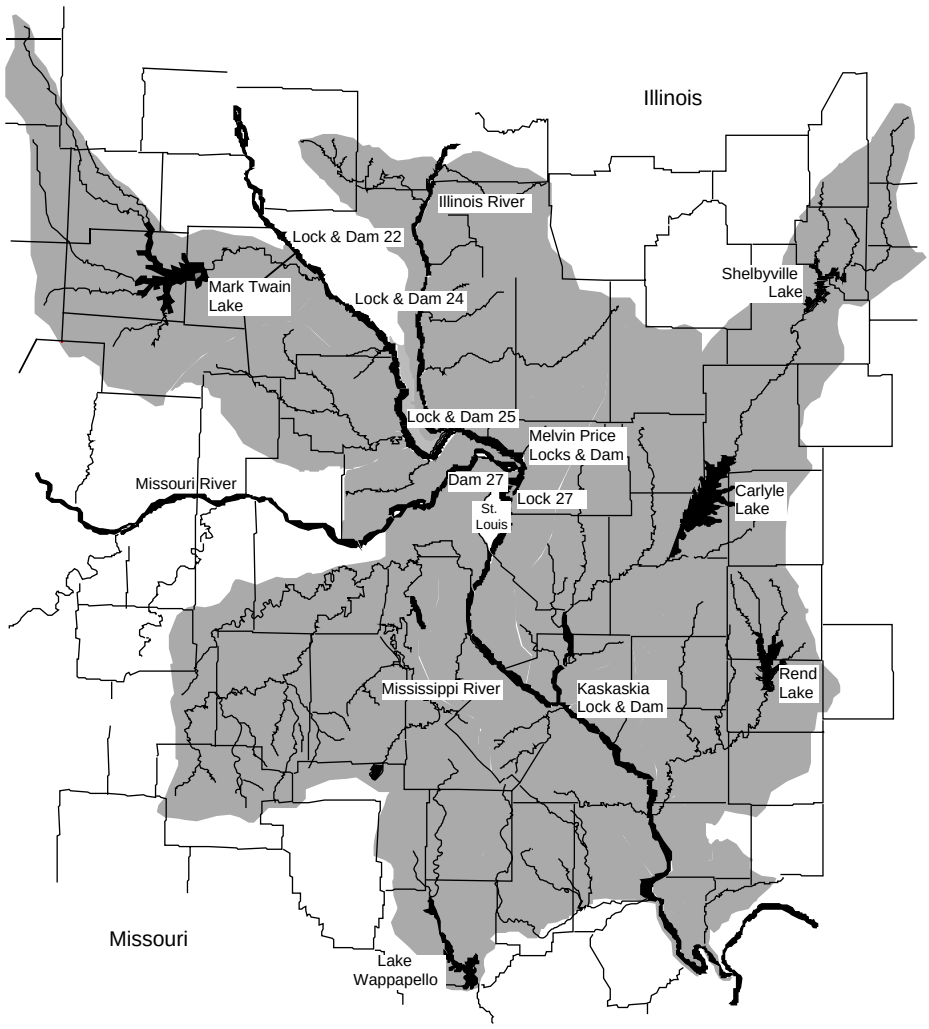

Figure 2. The St. Louis District.

within the St. Louis District were documented in the CRREL Ice Jam Database. Unlike the database as a whole, for which about 85% of the entries list USGS sources, the St. Louis District records only 19 events (or 10%) with data obtained from USGS sources, including the annual Water Resources Data series for Missouri, Volume 1 for Illinois (Illinois except Illinois River Basin) and Volume 2 (Illinois River Basin), as well as USGS Water-Supply Paper 1678 (Patterson and Gamble 1968). Thus, the spatial and temporal biases associated with heavy reliance on USGS data that affect much of the database may not be present in the database entries for the St. Louis District.

Substantial additional information was obtained from Corps of Engineers reports and studies, the *Waterways Journal*, local newspapers, and CRREL memoranda and reports. Much of the historical information was collected from St. Louis District files and from newspapers such as the *Cairo Evening Citizen*, the *Alton Evening Telegraph*, and the *St. Louis Post Dispatch*.

Where do ice events occur in the St. Louis District?

The database contains information on ice events at 33 locations on only 16 rivers in Missouri and Illinois within the District boundaries (Fig. 3 and 4). Forty-six events are listed at locations in Illinois, and 136 in Missouri, although 157 of these events occur on the Mississippi River, which affects both states. The river with the next largest number of reported jams is the North River in Missouri, with five.

The highest number of ice events is recorded at St. Louis (106), partly because records for that location date from 1842. Cairo, Illinois, is next with 19 events, followed by Hannibal, Missouri, with eight, and Alton, Illinois, with four.

When do ice events occur in the St. Louis District?

The years with the highest numbers of reported jams are 1936, with seven, and 1940, 1951, and 1982, with six each. Most jams occurred in December and January (Fig. 5), although jams have occurred as early as November (six) and as late as March (six). Unlike many northern areas that report primarily breakup ice events, no events within the District are specifically identified as breakup events, while 29 are classified freezeup jams. The 75 ice events listed as being "closure" events (when the ice cover freezes at St. Louis) are thought to be primarily due to freezeup processes. The classification of 78 ice events is unknown.

Who is affected by ice events in the St. Louis District?

Navigation interests, including tow operators, shippers, and the Corps of Engineers, are most affected by ice events in the St. Louis District. Damages include structural harm to dams, gates, locks, mooring and fleeting areas, and damage to navigation aids, as well as delays and stoppages of navigation traffic.

For example, in 1958, the *Cairo Evening Citizen* reported, "The Mississippi's enforced tie-up here [Cairo, Illinois] of as many as 15 boats at one time and hundreds of barges, representing a value of many millions of dollars in equipment and cargo, took a big bite out of the pocketbook of the boat and barge owners."

In another incident, this time above St. Louis, John Auble, Jr., of the *St. Louis Globe Democrat*, reported on 8 January 1968, "The Illinois River, here between Grafton and Hardin, Illinois, looks more like an arctic wasteland than a waterway.... [Eighteen] river boats and more barges than you can readily count, are being held captive.... The 5000-hp *Albert M* and the *John Morrow* have worked tirelessly chopping away at the ice. [The] *Travis*, at one time late Saturday, was holding 23 barges, straining 'full ahead' and not moving an inch." Up to 139 barges were reported held captive by the jam (*Alton Evening Telegraph* 1968).

Ice event damages in the St. Louis District

The costs associated with delays and stoppages of navigation caused by ice are difficult to determine as there appears to be no central clearinghouse for

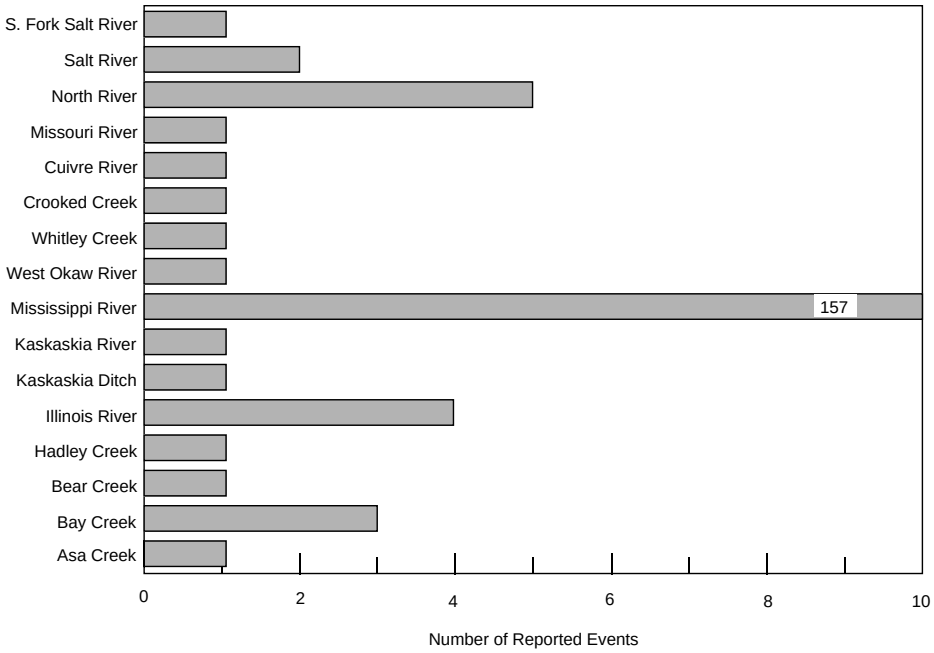

Figure 3. St. Louis District rivers for which ice events are reported.

such information. A search of Corps reports and newspapers revealed damage estimates (reported here in contemporary and 1998 dollars, respectively) for only five years: 1909 (>$80K [$5M]), 1951 ($760K [$6.3M]), 1958 ($961K [$6.1M]), 1962 (>$800K [$4.6M] in shipping alone), and 1977 ($6.75M [$15.7M] in shipping and $1.5M [$3.5M] in structural costs). Anecdotal evidence indicates approximately $10M ($12.6M) in structural damage during the 1989–1990 jam at the Mississippi-Missouri confluence. These estimates, except for 1977 (U.S. Army Corps of Engineers 1977), are thought to be conservative as they do not include all types of damage (e.g., increased operation and maintenance, structural damage, loss of perishable goods, flood-fighting efforts, damage to towboats and barges, etc.).

In many years, as was reported in 1977 (*Cairo Evening Citizen* 1977), there is "tremendous economic pressure to get the river open and moving again.... [St. Louis District public information officer Mel Doernhoeser] said that each day a vessel is tied up it could mean from $3–5,000 to the company.... [T]he inland water transport system transports about 16 percent of the total shipping in the nation and...some of the more valuable commodities are primarily shipped by boat. Many of the places...where the barges are docked are inaccessible from land and...even if rail or trucking facilities could reach them, they would not be able to handle the excess cargo [because] one barge holds 15 rail cars of cargo." That year, 500 barges were delayed between Lock and Dam 26 and 27.

Ice-related damage can occur even when ice is not the actual damaging force, as was the case in 1962. That year a large ice jam formed on the Mississippi River, trapping about 250 barges near Cairo. Somehow a group of barges came loose, creating a domino effect that eventually loosed more than 150 barges, sinking at least two, damaging harbor facilities, and heavily damaging a towboat in the rescue effort. At a cost of about $65K for each barge, and perhaps double including the content (*Cairo Evening Citizen* 1962), nearly $1M in damages resulted.

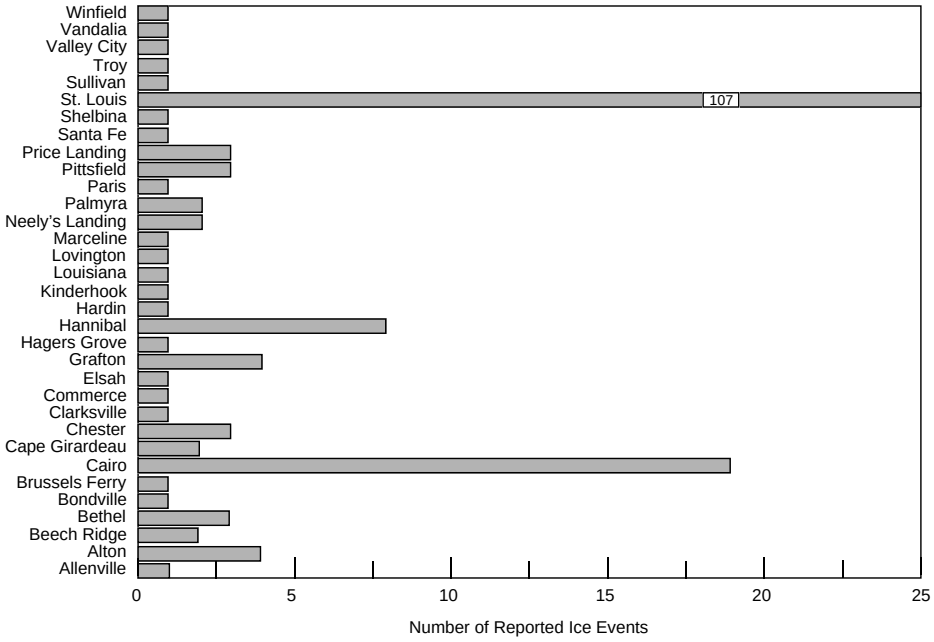

Figure 4. Locations reporting ice events in the St. Louis District.

Ice control in the St. Louis District

The Corps of Engineers and members of the navigation industry, as well as the Coast Guard, have contributed time and resources to combat ice jams on the Mississippi and Illinois Rivers.

Historical records contain numerous reports of towboats, including those operated by the Corps, attempting to loosen ice and create navigation channels. Figure 6 shows a typical operation: two tows breaking ice in a lock forebay. In 1979, the cost of ice operations by towboats was estimated to be about $1000 to $1500 per day, not including damage to the towboats, according to the *Boston Globe*, which reported an official as saying, "For the last three years it's been an annual event.... I think everybody who has sent in a boat has experienced some damage."

The St. Louis District and the Corps of Engineers (through its Cold Regions Engineering Program) have recently funded studies to examine the causes of, and possible solutions to, ice problems in the District. These include an examination of ice control in the middle Mississippi River (Tuthill and Mamone 1998) and lower Missouri River. Ice jamming at the Missouri–Mississippi confluence has also been studied (Ettema et al. 1997).

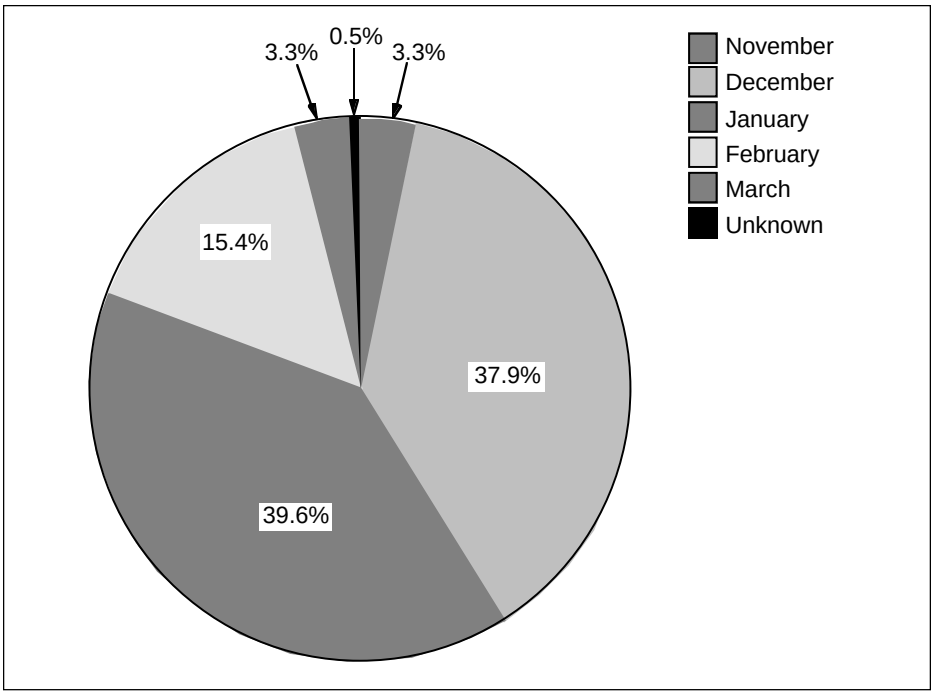

Figure 5. Monthly distribution of ice events reported in the St. Louis District.

Figure 6. Towboats H.L. Frieberg *(left) and* Dan Luckett *(right) breaking ice in the upper lock forebay, Lock and Dam 26 (10 February 1965).*

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Ice Engineering Information Exchange Bulletin

The *Ice Engineering Information Exchange Bulletin* is published in accordance with AR 25-30 as one of the information exchange functions of the Corps of Engineers. It is primarily intended to be a forum whereby information on ice engineering work done or managed by Corps field offices can be disseminated to other Corps offices, other U.S. Government agencies, and the engineering community in general. The purpose of the *Ice Engineering Information Exchange Bulletin* is information exchange and not the promulgation of Corps policy; thus, guidance on recommended practice in any given area should be sought through appropriate channels or in other documents. This bulletin's contents are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

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